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- (8) Idle rpm.
- (9) Fuel consumption at maximum power and torque.
- (10) Maximum air flow.
- (11) Air inlet restriction.
- (12) Exhaust pipe diameter(s).
- (13) Maximum exhaust system backpressure.

(c) *Test data; general.*

- (1) Engine-system combination.
- (2) Engine identification number.
- (3) Instrument operator.
- (4) Engine operator.
- (5) Number of hours of operation accumulated on the engine prior to beginning the warm-up portion of the test.

- (6) Fuel identification.

- (7) Date of most recent analytical assembly calibration.

- (8) All pertinent instrument information such as tuning, gain, serial numbers, detector number, and calibration curve numbers. As long as this information is available for inspection by the Administrator, it may be summarized by system number or analyzer identification numbers.

(d) *Test data; pre-test.*

- (1) Date and time of day.
- (2) Test number.
- (3) Intermediate speed and rated speed as defined in § 89.2 and maximum observed torque for these speeds.
- (4) Recorder chart or equivalent. Identify the zero traces for each range used, and span traces for each range used.
- (5) Air temperature after and pressure drop across the charge air cooler (if applicable) at maximum observed torque and rated speed.

(e) *Test data; modal.*

- (1) Recorder chart or equivalent. Identify for each test mode the emission concentration traces and the associated analyzer range(s). Identify the start and finish of each test.
- (2) Observed engine torque.
- (3) Observed engine rpm.
- (4) Record engine torque and engine rpm continuously during each mode with a chart recorder or equivalent recording device.
- (5) Intake air flow (for raw mass flow sampling method only) and depression for each mode.

- (6) Engine intake air temperature at the engine intake or turbocharger inlet for each mode.

- (7) Mass fuel flow (for raw sampling) for each mode.

- (8) Engine intake humidity.

- (9) Coolant temperature outlet.

- (10) Engine fuel inlet temperature at the pump inlet.

(f) *Test data; post-test.*

- (1) Recorder chart or equivalent. Identify the zero traces for each range used and the span traces for each range used. Identify hangup check, if performed.

- (2) Total number of hours of operation accumulated on the engine.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57015, Oct. 23, 1998]

§ 89.406 Pre-test procedures.

- (a) Allow a minimum of 30 minutes warmup in the standby or operating mode prior to spanning the analyzers.

- (b) Replace or clean the filter elements and then vacuum leak check the system per § 89.316(a). Allow the heated sample line, filters, and pumps to reach operating temperature.

- (c) Perform the following system checks:

- (1) Check the sample-line temperatures (see § 89.309(a)(4)(ii) and (a)(5)(i)(A)).

- (2) Check that the system response time has been accounted for prior to sample collection data recording.

- (3) A hang-up check is permitted, but is optional.

- (d) Check analyzer zero and span at a minimum before and after each test. Further, check analyzer zero and span any time a range change is made or at the maximum demonstrated time span for stability for each analyzer used.

- (e) Check system flow rates and pressures.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57015, Oct. 23, 1998]

§ 89.407 Engine dynamometer test run.

- (a) Measure and record the temperature of the air supplied to the engine, the fuel temperature, the intake air humidity, and the observed barometric pressure during the sampling for each mode. The fuel temperature shall be

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less than or equal to 43C during the sampling for each mode.

(b) The governor and fuel system shall have been adjusted to provide engine performance at the levels reported in the application for certification required under § 89.115.

(c) The following steps are taken for each test:

(1) Install instrumentation and sample probes as required.

(2) Perform the pre-test procedure as specified in § 89.406.

(3) Read and record the general test data as specified in § 89.405(c).

(4) Start cooling system.

(5) Precondition (warm up) the engine in the following manner:

(i) For variable-speed engines:

(A) Operate the engine at idle for 2 to 3 minutes;

(B) Operate the engine at approximately 50 percent power at the peak torque speed for 5 to 7 minutes;

(C) Operate the engine at rated speed and maximum horsepower for 25 to 30 minutes;

(ii) For constant-speed engines:

(A) Operate the engine at minimum load for 2 to 3 minutes;

(B) Operate the engine at 50 percent load for 5 to 7 minutes;

(C) Operate the engine at maximum load for 25 to 30 minutes;

(iii) Optional. It is permitted to precondition the engine at rated speed and maximum horsepower until the oil and water temperatures are stabilized. The temperatures are defined as stabilized if they are maintained within 2 percent of point on an absolute basis for 2 minutes. The engine must be operated a minimum of 10 minutes for this option. This optional procedure may be substituted for the procedure in paragraph (c)(5)(i) or (c)(5)(ii) of this section;

(iv) Optional. If the engine has been operating on service accumulation for a minimum of 40 minutes, the service accumulation may be substituted for the procedure in paragraphs (c)(5)(i) through (iii) of this section.

(6) Read and record all pre-test data specified in § 89.405(d).

(7) Start the test cycle (see § 89.410) within 20 minutes of the end of the warmup. (See paragraph (c)(13) of this section.) A mode begins when the speed and load requirements are stabilized to

within the requirements of § 89.410(b). A mode ends when valid emission sampling for that mode ends. For a mode to be valid, the speed and load requirements must be maintained continuously during the mode. Sampling in the mode may be repeated until a valid sample is obtained as long the speed and torque requirements are met.

(8) Calculate the torque for any mode with operation at rated speed.

(9) During the first mode with intermediate speed operation, if applicable, calculate the torque corresponding to 75 and 50 percent of the maximum observed torque for the intermediate speed.

(10) Record all modal data specified in § 89.405(e) during a minimum of the last 60 seconds of each mode.

(11) Record the analyzer(s) response to the exhaust gas during the a minimum of the last 60 seconds of each mode.

(12) Test modes may be repeated, as long as the engine is preconditioned by running the previous mode. In the case of the first mode of any cycle, precondition according to paragraph (c)(5) of this section.

(13) If a delay of more than 20 minutes, but less than 4 hours, occurs between the end of one mode and the beginning of another mode, precondition the engine by running the previous mode. If the delay exceeds 4 hours, the test shall include preconditioning (begin at paragraph (c)(2) of this section).

(14) The speed and load points for each mode are listed in Tables 1 through 4 of Appendix B of this subpart. The engine speed and load shall be maintained as specified in § 89.410(b).

(15) If at any time during a test mode, the test equipment malfunctions or the specifications in paragraph (c)(14) of this section are not met, the test mode is void and may be aborted. The test mode may be restarted by preconditioning with the previous mode.

(16) Fuel flow and air flow during the idle load condition may be determined just prior to or immediately following the dynamometer sequence, if longer times are required for accurate measurements.

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(d) *Exhaust gas measurements.* (1) Measure HC, CO, CO₂, and NO_x concentration in the exhaust sample.

(2) Each analyzer range that may be used during a test mode must have the zero and span responses recorded prior to the execution of the test. Only the zero and span for the range(s) used to measure the emissions during the test are required to be recorded after the completion of the test.

(3) It is permissible to change filter elements between test modes.

(4) A leak check is permitted between test segments.

(5) A hangup check is permitted between test segments.

(6) If, during the emission measurement portion of a test segment, the value of the gauges downstream of the NDIR analyzer(s) *G3* or *G4* (see Figure 1 in appendix B to subpart D) differs by more than ± 0.5 kPa from the pretest value, the test segment is void.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57015, Oct. 23, 1998]

§ 89.408 Post-test procedures.

(a) A hangup check is recommended at the completion of the last test mode using the following procedure:

(1) Within 30 seconds introduce a zero-grade gas or room air into the sample probe or valve V2 (see Figure 1 in appendix B to subpart D) to check the “hangup zero” response. Simultaneously start a time measurement.

(2) Select the lowest HC range used during the test.

(3) Within four minutes of beginning the time measurement in paragraph (a)(1) of this section, the difference between the span-zero response and the hangup zero response shall not be greater than 5.0 percent of full scale or 10 ppmC whichever is greater.

(b) Begin the analyzer span checks within 6 minutes after the completion of the last mode in the test. Record for each analyzer the zero and span response.

(c) If during the test, the filter element(s) were replaced or cleaned, a of § 89.316(a), the test is void.

(d) Record the post-test data specified in § 89.405(f).

(e) For a valid test, the zero and span checks performed before and after each

test for each analyzer must meet the following requirements:

(1) The span drift (defined as the change in the difference between the zero response and the span response) must not exceed 3 percent of full-scale chart deflection for each range used.

(2) The zero response drift must not exceed 3 percent of full-scale chart deflection.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57016, Oct. 23, 1998]

§ 89.409 Data logging.

(a) A computer or any other automatic data processing device(s) may be used as long as the system meets the requirements of this subpart.

(b) Determine from the data collection records the analyzer responses corresponding to the end of each mode.

(c) Record data at a minimum of once every 5 seconds.

(d) Determine the final value for CO₂, CO, HC, and NO_x concentrations by averaging the concentration of each point taken during the sample period for each mode.

(e) For purposes of this section, calibration data includes calibration curves, linearity curves, span-gas responses, and zero-gas responses.

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§ 89.410 Engine test cycle.

(a) Emissions shall be measured using one of the test cycles specified in Tables 1 through 4 of Appendix B of this subpart, subject to the provisions of paragraphs (a)(1) through (a)(4) of this section. These cycles shall be used to test engines on a dynamometer.

(1) The 8-mode test cycle described in Table 1 of Appendix B of this subpart shall be used for all engines, except constant speed engines, engines rated under 19 kW, and propulsion marine diesel engines.

(2) The 5-mode test cycle described in Table 2 of Appendix B of this subpart shall be used for constant-speed engines as defined in § 89.2. Any engine certified under this test cycle must meet the labeling requirements of § 89.110(b)(11).

(3) The 6-mode test cycle described in Table 3 of Appendix B of this subpart